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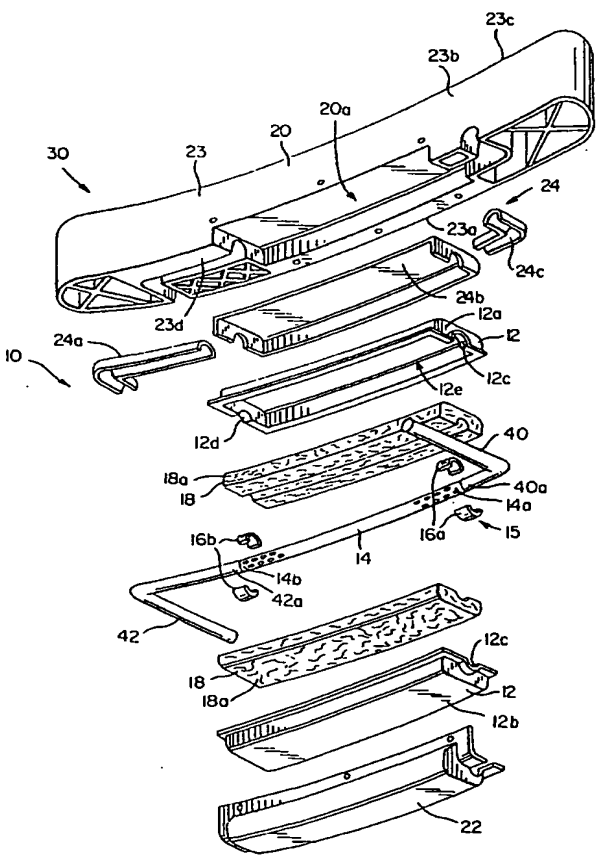
(54) Title: BUMPER/MUFFLER ASSEMBLY



(57) Abstract: A bumper/muffler assembly (30) is provided comprising a bumper (20); and a muffler (10) having an outer shell (12). The outer shell may be formed from a non-high impact resistant material, such as a thin metal or a composite material. The muffler may comprise a separate element from the bumper, which is coupled thereto, or is formed as an integral part of the bumper.

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BUMPER/MUFFLER ASSEMBLY

TECHNICAL FIELD AND INDUSTRIAL APPLICABILITY OF THE INVENTION

This invention relates to a bumper/muffler assembly wherein a muffler, preferably made from a composite material, is associated with a vehicle bumper.

BACKGROUND OF THE INVENTION

U.S. Patent No. 5,726,398 to Zahn et al. discloses a bumper/muffler assembly. A portion of the structure defining the muffler also forms part of the bumper and, hence, must be capable of absorbing high impact loads. If, after a certain period of vehicle operation, the muffler becomes defective and must be replaced, those defective parts must be replaced with costly parts capable of performing dual functions -- attenuate acoustic energy and absorb high impact loads. The '398 patent also teaches that the bumper/muffler assembly may be formed from metal, see column 2, line 41. There are inherent limitations from a design standpoint regarding possible shapes and sizes for metal mufflers. Hence, the ability to design mufflers capable of being received in irregularly shaped vehicle recesses or cavities is restricted. It is also noted that the tooling costs for metal mufflers is very high, which is problematic where only a limited number of mufflers are to be produced, for example, less than 100,000.

Published International Application WO 99/27238 discloses a silencer formed from a composite material, such as a glass filled nylon (nylon 66). It does not, however, teach incorporating such a device into a vehicle bumper.

Hence, there is a need for an improved, low-cost muffler, which is capable of being associated with a vehicle bumper. Preferably, the muffler is made from a lightweight material, not required to absorb high impact loads.

SUMMARY OF THE INVENTION

These needs are met by the present invention, wherein improved bumper/muffler assemblies are provided. In these assemblies, the muffler outer shell may be formed from a lightweight metal or a composite material. Such materials are typically less expensive than thicker metals designed to also absorb high impact loads. Composite outer shells are further advantageous as tooling costs for such parts are typically lower than for metal

impact protection for the muffler shell. A portion of the main body may define at least a part of an outer shell of the muffler.

In accordance with a second aspect of the present invention, a bumper/muffler/exhaust pipe system is provided comprising a bumper/muffler assembly, at least one exhaust pipe and a flex section. The bumper/muffler assembly includes a muffler having an outer shell and a perforated pipe extending through the outer shell. The muffler is associated with the bumper. The flex section couples the exhaust pipe to the perforated pipe.

The flex section may be welded, clamped or otherwise coupled to the exhaust pipe.

The bumper/muffler/exhaust pipe system may further comprise a bushing having an outer surface engaging the outer shell and an inner surface engaging the flex section. The flex section may extend only part way through the bushing such that it abuts the perforated pipe. It is also contemplated that the flex section may extend completely through the bushing.

The flex section may comprise a flexible woven metal tube.

In accordance with a third aspect of the present invention, a bumper/muffler assembly is provided comprising a bumper, and a muffler. The muffler is associated with the bumper and includes an outer shell and a perforated pipe with opposing ends. The perforated pipe extends through the outer shell. At least one bushing assembly is positioned between the outer shell and the perforated pipe. The bushing assembly includes a first bushing having an angled outer surface. The first bushing is fixedly coupled to the perforated pipe. The bushing assembly further includes a second bushing having an angled inner surface and is positioned over the first bushing. The second bushing engages an inner surface of the outer shell and is capable of moving relative to the first bushing and the outer shell. A spring is fixedly coupled to the perforated pipe and engages an inner, side surface of the second bushing for biasing the second bushing outwardly toward a corresponding end of the perforated pipe.

In accordance with a fourth aspect of the present invention, a bumper/muffler assembly is provided comprising a bumper, and a muffler having an outer shell formed from a non-high impact resistant material. The muffler is associated with the bumper. The outer shell does not comprise a high impact-resistant structural component of the bumper.

for example, it may have a length up to almost the length of the bumper, for example, greater than 60 inches (152.4 centimeters), such that the muffler operates more efficiently, especially in dissipating low frequency acoustic energy.

Referring now to Fig. 1, which is an exploded view illustrating a muffler 10, constructed in accordance with a first embodiment of the present invention, and a vehicle bumper 20. When those two elements are assembled together, they define a bumper/muffler assembly 30.

The muffler 10 comprises a rigid outer shell 12 defined by first and second shell parts 12a and 12b. The shell parts 12a and 12b are formed from a metal, a resin or a composite material comprising, for example, reinforcement fibers and a resin material. When formed from a composite material, the resin material may comprise any commercially available phenolic resin, including but not limited to phenol-formaldehyde resins such as novolac and resole resins; epoxy resins; vinyl ester resins; polyphenylene sulfide; high temperature nylons, one of which is commercially available from E.I. Du Pont de Nemours and Co. under the trademark ZYTEL® HTN, and another of which is commercially available from Amoco Performance Products, Inc. as polythalamide and sold under the trademark AMODEL®; nylon 6,6, one of which is commercially available from E.I. Du Pont de Nemours and Co. under the trademark ZYTEL®; and polyetheretherketone (PEEK). The reinforcement fibers forming part of the outer shell 12 may comprise glass fibers (such as but not limited to E-glass and S-2 glass fibers), graphite fibers, aramid fibers such as those sold under the trademark KEVLAR®, carbon fibers, metallic fibers and/or ceramic fibers. The composite shell parts 12a and 12b may be formed using a conventional injection molding or compression molding process wherein the reinforcement fibers and resin are combined prior to being injected or placed into the mold, or may be formed using any other known process for forming such parts. It is also contemplated that the shell 12 could be formed as a one piece shell via a blow molding, injection molding, compression molding, vacuum forming, squeeze molding, thermo-forming or like process.

Extending through the outer shell 12 is a perforated metal pipe 14 formed, for example, from a stainless steel. In the illustrated embodiment, the perforated pipe 14 is frictionally held within the outer shell 12 via first and second bushings 16a and 16b. As noted above, the rigid outer shell 12 may be formed from a metal, a resin or a composite material. In Fig. 1, the bushings 16a and 16b are illustrated as two-component bushings.

which are separated or texturized via pressurized air so as to form a loose wool-type product in the outer shell 12, see U.S. Patent Nos. 5,976,453 and 4,569,471, the disclosures of which are incorporated herein by reference. The filaments may be formed from, for example, E-glass or S-glass, or other glass compositions. The continuous strand material may comprise an E-glass roving sold by Owens Corning under the trademark ADVANTEX® or an S-glass roving sold by Owens Corning under the trademark ZenTron®.

It is also contemplated that ceramic fiber material may be used instead of glass fibrous material to fill the outer shell 12. Ceramic fibers, if continuous, could be filled directly into the shell or used to form a preform which is subsequently placed in the shell 12. It is also contemplated that preforms may be made from a discontinuous glass fiber product produced via a rock wool process or a spinner process used to make fiber glass used as thermal insulation in residential and commercial applications. It is further contemplated that stainless steel could be wrapped about the perforated pipe 14 or made into a cylindrical preform and then slipped over the pipe 14 prior to the pipe 14 being inserted into the outer shell. It is additionally contemplated that an E-glass needle felt mat, made into a cylindrical preform, could be slipped over the perforated pipe 14. A layer of stainless steel could be provided between the needle felt mat preform and the perforated pipe 14.

In the illustrated embodiment, continuous glass strands have been texturized and formed into a pair of preforms 18a. Each preform 18a is placed in one of the shell parts 12a or 12b prior to the shell parts 12a and 12b being coupled together. Processes and apparatus for forming such preforms are disclosed in U.S. Patent Nos. 5,766,541 and 5,976,453, the disclosures of which are incorporated herein by reference; and in patent application, U.S. Serial No. 08/802,492, the disclosure of which is also incorporated herein by reference.

Acoustic energy passes through the perforated pipe 14 to the fibrous material 18 which functions to dissipate the acoustic energy. The fibrous material 18 also functions to thermally protect or insulate the outer shell 12 from energy in the form of heat transferred from high temperature exhaust gases passing through the pipe 14. In the illustrated embodiment, continuous glass strands have been texturized and formed into a pair of preforms 18a. Each preform 18a is placed in one of the shell parts 12a or 12b prior to the shell parts 12a and 12b being coupled together. Processes and apparatus for forming such

shell 12 and the pipe 14 prior to the bushings 16a and 16b being press-fitted onto the pipe ends.

The outer shell 12, the perforated pipe 14, the bushings 16a and 16b and the strand material define the muffler 10.

The bumper 20 comprises a main body 23 having a front surface 23a, a rear surface 23b, an upper surface 23c and a lower surface 23d. The front surface 23a faces away from a vehicle to which the bumper 20 is coupled. The rear surface 23b faces toward the vehicle. The upper surface 23c faces away from ground and the lower surface 24d faces toward ground. The main body 23 further includes a recess 20a formed in the rear and lower surfaces 23b and 23d for receiving the muffler shell 12 such that the main body 23 provides impact protection for the muffler shell 12.

A cover 22 is bolted or otherwise coupled to the bumper 20 so as to secure the muffler 10 to the bumper 20 as well as to provide additional impact protection for the muffler 10. The bumper 20 is typically formed from a composite material, that is, resin material and reinforcement fibers. The bumper 20 may also comprise a metal frame encased in a polymeric or composite material shell. The cover 22 may be formed from a composite material. The cover 22 may also be formed from a metal so as to provide a means to transfer heat generated by the muffler 10 away from the muffler 10, to reduce costs and to enhance the strength of the cover 22 and the bumper 20. It is also contemplated that the outer shell 12 may be shaped and provided with appropriate openings for receiving bolts such that a separate cover is not required. In this embodiment, the outer shell is bolted or otherwise fastened directly to the bumper 20.

It is contemplated that a heat shield formed from a metal or another material such as a foamed inorganic material and acting as a heat insulator could be provided between the muffler 10, portions of exhaust pipes 40 and 42 and any resin based component in the bumper 20. However, the fibrous material 18 in the muffler 10 may be sufficient to keep the temperature of the muffler outer shell 12 cool enough that the bumper 20 itself would not need to be thermally protected from the muffler 10. It is likely, though, that the bumper 20 may need to be thermally protected from the exhaust pipes 40 and 42. In the illustrated embodiment, a heat shield 24 comprising first, second and third sections 24a-24c is provided. Section 24b is provided between the muffler 10 and bumper 20, see Fig. 1. Sections 24a and 24c are positioned between the bumper 20 and portions of the pipes 40 and 42, discussed below, coupled to the perforated pipe 14 and positioned near the

illustrated in Fig. 1B) of a corresponding exhaust pipe 40 or 42. The opposing end 50b of the flex pipe section is press-fitted into its corresponding bushing 16a and 16b and may extend part way through the bushing along with a corresponding end of the perforated pipe 14 so as to be coupled to the perforated pipe 14. The rigid outer shell 12 in this embodiment may be formed from a metal, a resin or a composite material.

Alternatively, a slip joint connection may be substituted for such flex pipe sections. A slip joint is advantageous as it compensates for expansion of an exhaust pipe extending from a vehicle catalytic converter and coupled via a slip joint to the perforated pipe 14.

In a third alternative embodiment illustrated in Fig. 1C, where like elements are referenced by like reference numerals, flex pipe sections 500, only one of which is shown in Fig. 1C, are used to couple the perforated pipe 14 to the first and second exhaust pipes 40 and 42. The flex pipe sections 500 comprise flexible steel tubes and are commercially available from any one of the suppliers set out above from which the flex pipe sections 50 are available. In this embodiment, a first end 500a of each flex pipe section 500 is fitted over an end 40a or 42a of its corresponding exhaust pipe 40 or 42 and clamped thereon via a clamp 510. It is also contemplated that the first end 500a could be welded, brazed or otherwise coupled to an exhaust pipe end. In the illustrated embodiment, the second end 500b of each flex pipe section 500 is welded to an end of the perforated pipe 14. It is also contemplated that each second end 500b could be clamped or otherwise coupled to an end of the perforated pipe 14. The rigid outer shell 12 in the Fig. 1C embodiment may be formed from a metal, a resin or a composite material.

If the bushings 16a and 16b in the second and third alternative embodiments are formed from a ceramic material, it is contemplated that a layer of ceramic fibers may be interposed between the bushings 16a and 16b and the flex pipe sections 50, 500 so as to prevent exhaust gases from passing between the flex pipe sections 50, 500 and the bushings 16a and 16b. The ceramic fiber layer may comprise a ceramic tape or mat (not shown), having a thickness of about 1 mm. The tape or mat may be adhesively coupled to the inner surface of each ceramic bushing via an adhesive so as to hold the tape or mat in place as a flex pipe section is press-fitted into place within its corresponding bushing.

If an end portion of an exhaust pipe 40 or 42 is press-fitted directly into one of the ceramic bushings 40 or 42, upon being heated, it will place the ceramic bushing in a state of tension causing the bushing to be susceptible to fracture. This occurs when the pipe end expands to a greater extent as it is heated than the ceramic bushing. The flex pipe sections

and contraction of the perforated pipe 14 results in the first and second bushings 160 and 162 moving substantially together, that is, like amounts.

In the illustrated embodiment, the exhaust pipes 40 and 42 are clamped via clamps 180 to ends 14a and 14b of the perforated pipe 14 at locations outside of the outer shell 12. The pipes 40 and 42 may also be welded to the pipe ends 14a and 14b. The rigid outer shell 12 in the Fig. 1D embodiment may be formed from a metal, a resin or a composite material.

In a fifth alternative embodiment, illustrated in Fig. 1E, where like elements are referenced by like reference numerals, first and second exhaust pipes (only first exhaust pipe 540 is illustrated) are coupled to opposing ends 14a and 14b of the perforated pipe 14. The ends 14a and 14b of the perforated pipe 14 extend completely through the bushings 16a and 16b. Crimped ends of the exhaust pipes (only crimped end 540a of first exhaust pipe 540 is illustrated) are inserted into open ends of the perforated pipe 14 and are welded to the perforated pipe ends at locations spaced from the outer shell 12, see weld bead 43 shown in Fig. 1E. In this embodiment, the bushings 16a and 16b are preferably formed from a polymeric material, but it is also contemplated that a ceramic material may be used as well. The rigid outer shell 12 may be formed from a metal, a resin or a composite material.

In a sixth alternative embodiment, illustrated in Fig. 1F, where like elements are referenced by like reference numerals, first and second exhaust pipes (only exhaust pipe 540 is illustrated) are coupled to the opposing ends 14a and 14b of the perforated pipe 14 via the bushings 16a and 16b and first and second flex pipe sections 600, only one of which is shown in Fig. 1F. The flex pipe sections 600 comprise flexible steel tubes and are commercially available from any one of the suppliers set out above from which the flex pipe sections 50 are available. In this embodiment, a crimped end of each first and second exhaust pipe (only crimped end 540a of the first exhaust pipe 540 is illustrated) is inserted into a first end 600a of a corresponding flex pipe section 600. The flex pipe section first end 600a is then clamped to its corresponding exhaust pipe via a clamp 610. It is also contemplated that the first end 600a could be welded, brazed or otherwise coupled to an exhaust pipe end. In the illustrated embodiment, the second end 600b of each flex pipe section 600 is welded to an end of the perforated pipe 14. It is also contemplated that each second end 600b could be clamped or otherwise coupled to an end

faces away from a vehicle to which the bumper 600 is coupled. The rear surface 623b faces toward the vehicle. The upper surface 623c faces away from ground and the lower surface 624d faces toward ground. The main body 623 further includes a recess 620a formed in the rear and upper surfaces 623b and 623c for receiving the muffler shell 12 such that the main body 623 provides impact protection for the muffler shell 12.

A cover 22 is bolted or otherwise coupled to the bumper 600 so as to secure the muffler 10 to the bumper 600 as well as to provide additional impact protection for the muffler 10. The bumper 600 may be formed from any one of the materials noted above from which bumper 20 is formed.

In the Fig. 4 embodiment, a heat shield 24 comprising first, second and third sections 24a-24c is provided between the muffler 10, portions of the exhaust pipes 40 and 42 and the bumper 600. The heat shield sections 24a-24c are formed from the same materials from which sections 24a-24c, illustrated in Fig. 1 and discussed above, are formed. Further heat shield sections 624a and 624b, which may be formed from the same materials from which heat shield sections 24a-24c are formed, are provided between the vehicle (not shown) and portions of the pipes 40 and 42.

In an alternative embodiment, outer shell part 12a may be formed as an integral part of the bumper 600. The bumper may be formed from a metal in this embodiment. In this embodiment, a shield second section 24b is not provided. A separate outer shell part 12b is provided.

In the embodiments illustrated in Figs. 1, 2 and 4, all elements of the muffler are separate and distinct from the bumper, i.e., the muffler parts are not integral with any portion of the bumper. This may be advantageous in the event that one or more parts of the muffler become defective or are damaged and need replacing. Replacement of the defective/damaged parts can be more easily effected and the cost of replacement parts most likely will be less expensive in these embodiments than in the case where the replacement part is integral with a larger, and potentially more expensive portion of the bumper.

In each of the embodiments discussed above, the perforated and exhaust pipes may have geometric shapes which differ from those illustrated in Figs. 1, 1A-1D and 2-4.

11. A bumper/muffler assembly as set forth in claim 10, wherein a portion of said main body (23) defines at least a part of an outer shell (12) of said muffler (10).

12. A bumper/muffler/exhaust pipe system comprising:

a bumper/muffler assembly (30) comprising a bumper (20), and a muffler (10) having an outer shell (12) and a perforated pipe (14) extending through said outer shell, said muffler being associated with said bumper;

at least one exhaust pipe (40); and

a flex section (50) for coupling said exhaust pipe to said perforated pipe.

13. A bumper/muffler/exhaust pipe system as set forth in claim 12, wherein said flex section (50) is one of welded and clamped to said exhaust pipe (40).

14. A bumper/muffler/exhaust pipe system as set out in claim 12, further comprising a bushing (16a) having an outer surface engaging said outer shell (12) and an inner surface engaging said flex section (50).

15. A bumper/muffler/exhaust pipe system as set out in claim 14, wherein said flex section (50) extends only part way through said bushing (16) and abuts said perforated pipe (14).

16. A bumper/muffler/exhaust pipe system as set out in claim 14, wherein said flex section (50) extends completely through said bushing (16).

17. A bumper/muffler/exhaust pipe system as set out in claim 12, wherein said flex section (50) comprises a flexible woven metal tube.

18. A bumper/muffler assembly comprising:

a bumper (20); and

a muffler (10) associated with said bumper including an outer shell (12) and a perforated pipe (14) with opposing ends (14a, 14b), said perforated pipe extending through said outer shell, and at least one bushing assembly positioned between said outer shell and said perforated pipe, said bushing assembly including a first bushing (160) having an angled outer surface (160a) and being fixedly coupled to said perforated pipe, a second bushing (162) having an angled inner surface (162a) and being positioned over said first bushing, said second bushing engaging an inner surface of said outer shell and being capable of moving relative to said first bushing and said outer shell, and a spring (170) fixedly coupled to said perforated pipe and engaging an inner, side surface of said second bushing for biasing said second bushing outwardly toward a corresponding end of said perforated pipe.

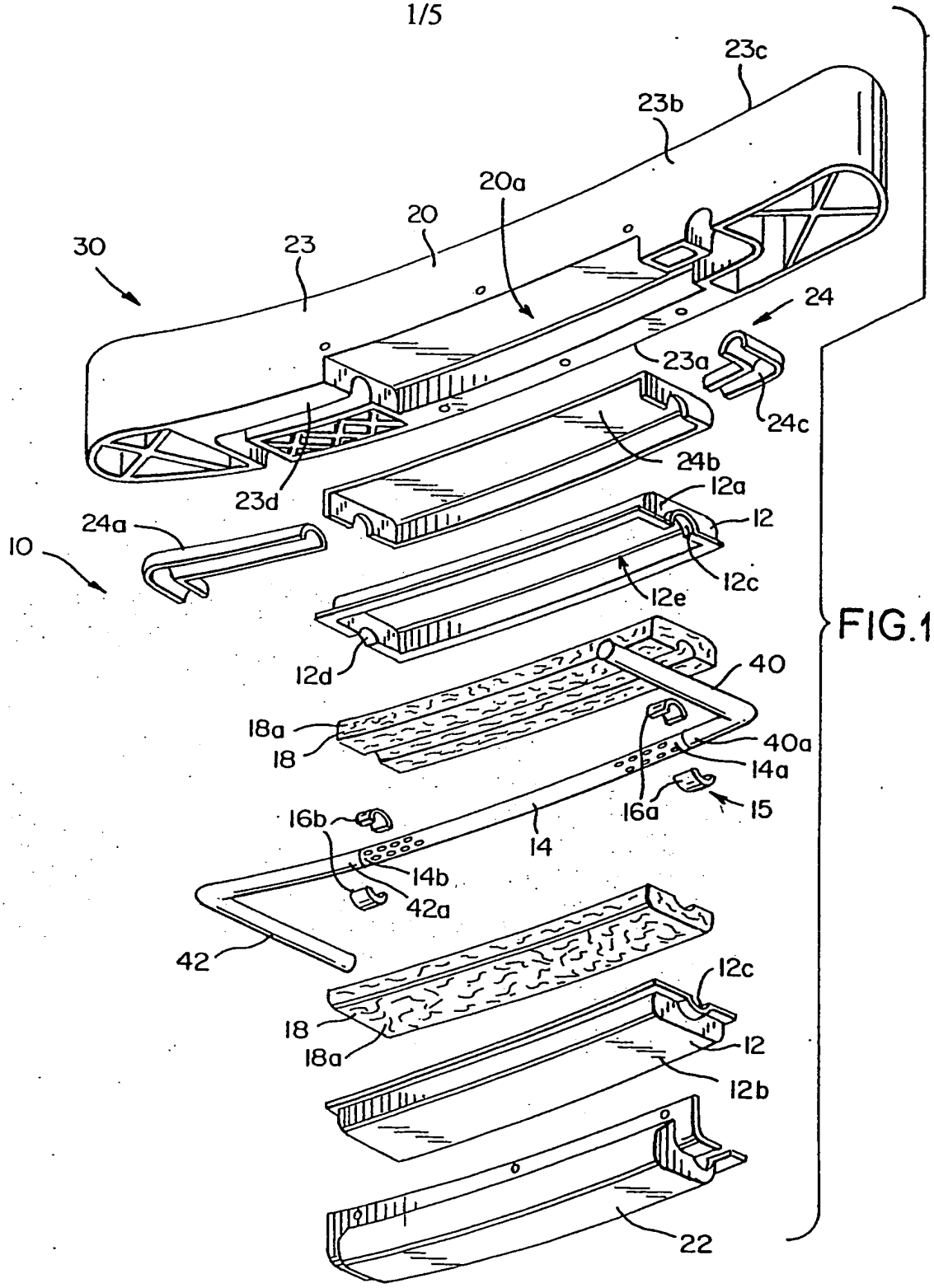
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FIG.1

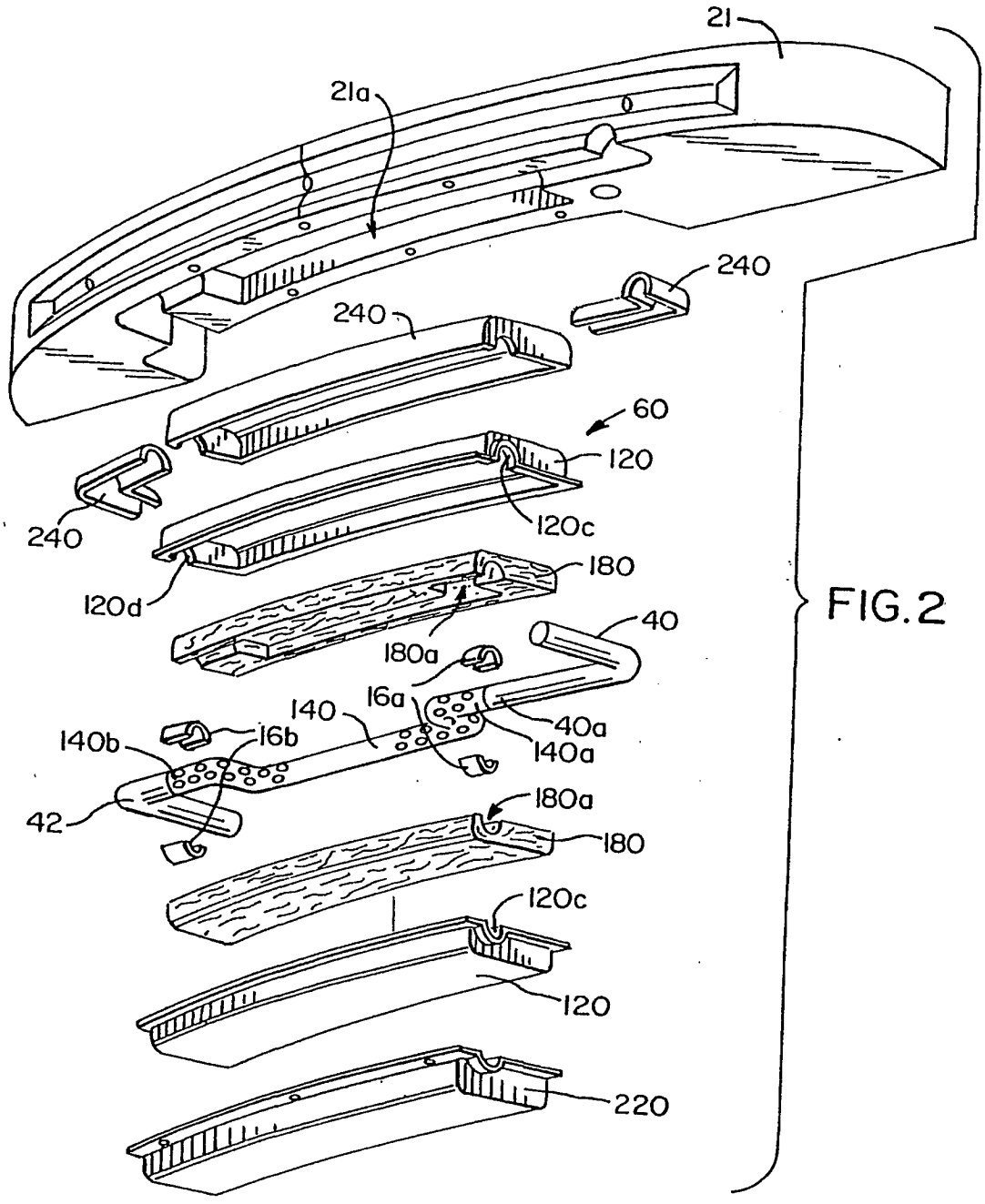
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FIG.2

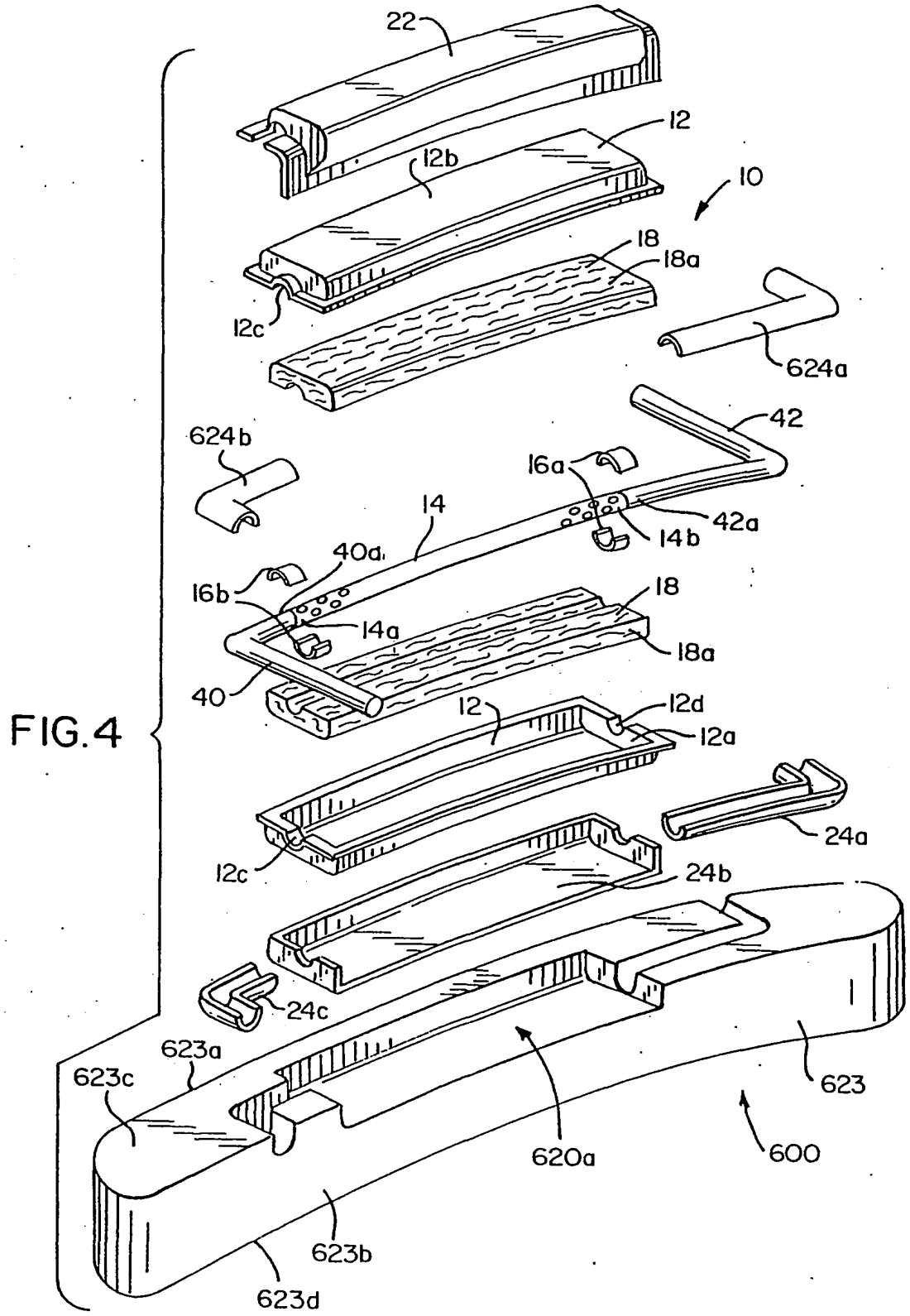

FIG.4

INTERNATIONAL SEARCH REPORT

Int[illegible]nal Application No
PCT/US 01/43428

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 766 541 A (NILSSON BENGT G ET AL) 16 June 1998 (1998-06-16) column 3, line 8 -column 4, line 36; figures 1-3	2-9, 21-30

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